PROTEOCEPHALUS GALLARDI.

A NEW CESTODE FROM THE BLACK SNAKE.

By T. HARVEY JOHNSTON, M.A., D.Sc.
Biological Department, University, Brisbane.

The Black Snake, *Pseudechis porphyriacus*, Shaw, is not infrequently the host of a number of species of parasites, amongst them being a hæmogregarine, *Hæmogregarina pseudechis*, Jnstn.,* found in the red-blood corpuscles; a pentastome, *Porocephalus teretiusculus*, Baird,† infesting the lungs; a nematode, *Physaloptera* sp., which lives in the stomach and duodenum; *Echinorhynchus* sp.,‡ found very commonly in the rectum; and a tapeworm previously recorded as *Ichthyotænia* sp.,§ and now described as *Proteocephalus gallardi*.

Hall ‖ has recently shown that the generic name *Proteocephalus* has priority over *Ichthyotænia*; consequently I have adopted the former designation in preference to the latter, though it is under *Ichthyotænia* that practically all of the species have been placed.

I have examined specimens of this cestode collected from the abovenamed snake in various parts of New South Wales and Victoria. The longest individual measures 40 cm. in length, its maximum breadth reaching 1.7 mm. Its anterior third is white, the remainder being yellowish with a dark-grey dendritic figure in each segment, the marking being due to the colour and form of the egg-laden uterus showing through the overlying tissues. The posterior third of this strobila contained ripe eggs, the eggs in the

* Johnston, Proc. Linn. Soc. N. S. Wales xxxiv, 1909, p. 406 (N.S.W.)

† Spencer, Q.J.M.S. xxxiv, 1892-3, p. 1, etc. (Vict. and King Is.); Proc. Roy. Soc. Vict. i (n.s.) 1888, p. 110 (King Is.)
Shipley, Arch. d. Parasitol. i 1898, p. 77.
Johnston, Jour. Proc. Roy. Soc. N.S.W. 1910, p. xvii. (N.S.W.)

‡ Johnston, Proc. Linn. Soc. N. S. Wales 1909, p. 590 (N.S.W.)

§ Johnston, Jour. Proc. Roy. Soc. N. S. Wales 1910, p. xi (N.S.W., Vict.), and p. xviii (Victoria).

‖ Hall, Proc. U. S. Nat. Museum xxxix, 1910, p. 146-8.

middle third being more or less immature. In another specimen of 10 cm. in length, ripe eggs were present in the latter portion of the chain.

The scolex is relatively broad (0.96 mm.) but is not marked off from the succeeding portion of the strobila. Its apex projects more or less prominently. In Fig. 1 it is a low cone, while in one case it was seen as a distinct rostellar-like structure. A retractile rostellum is absent. At the tip of the apex there is an apical sucker or perhaps more correctly an apical muscle-plug, there being a very small terminal cavity. This plug is not a powerful organ when compared with the four large suckers, which are very efficient organs of fixation. The latter measure about 0.44 mm. in transverse diameter, the deep cup-like cavity being directed almost anteriorly. There is a longitudinal furrow between each pair. The cuticle of the scolex, and especially its apex, bear abundance of minute backwardly directed and closely set bristles or spines similar to those found in many species of *Ichthyotænia (i.e., Proteocephalus)*. They are also present in the suckers. These tiny projections become gradually smaller in the succeeding portions of the chain, but are still recognisable in segments which have reached sexual maturity, though they are then very minute.

The scolex becomes gradually narrowed into a relatively long unsegmented neck. At about 8 mm. from the anterior end segmentation becomes recognisable by the development of transverse septa. There is no overlapping of proglottids, and, excepting in the case of ripe segments, segmentation is scarcely if at all visible to the naked eye, owing to the absence of marginal indentations in the anterior portions of the chain. Each segment is typically rectangular, the whole strobila very much resembling a narrow flat band. Ripe proglottids vary somewhat in size, being from 4.3 to 5.25 mm. in length by 1.0 to 1.2 mm. in width.

Musculature, &c.—The cuticle is a very thick layer (0.017 mm.) showing a distinct stratification, an outer more deeply staining layer, and an inner clearer and rather wider zone. Below it is a definite basement membrane succeeded by a well-defined layer of subcuticular circular muscle fibres. Immediately within these is the outer subcuticular longitudinal musculature, the fibres of

which though individually small are yet very numerous, and form a distinct and almost continuous narrow layer. The subcuticular cells are situated inwardly from these fibres, and between the cells one may readily recognise the inner series of subcuticular longitudinal muscles. The fibres are much larger and form small bundles. This series merges into another lying within it, and consisting of much larger bundles composed of larger fibres. The latter musculature spreads over a fairly wide area of the cortex lying within the subcuticular cells, and terminates at some little distance from the inner parenchyma muscles. They thus represent an outer series of longitudinal bundles. Separated externally from this by a narrow track free from muscular tissue, there lies the powerful inner longitudinal series consisting of numerous bundles varying in size and in the number of individual fibres contained in them. Although one may recognise an inner and an outer division in the middle region of this series, yet they really form one continuous ring. It is this musculature which makes the inner boundary of the cortex, as no transverse fibres were detected within it, though some were present, weakly developed, on the outer side of it. The relation of certain other structures to this longitudinal muscle ring may be mentioned here. The lateral nerve lies in line with or slightly outward from the lateral portion of the system, the vitelline glands being just dorsal to the nerve, both structures thus forming a part of the ring, as will be seen by glancing at Fig. 3. The excretory vessels lie very close to and sometimes actually between the bundles of their respective surfaces. There is no marked displacement of the bundles laterally by the genital ducts as they pass between them. Dorso-ventral fibres were not recognised.

The excretory system consists of the usual two pairs of longitudinal vessels, but transverse commissures are absent. The ventral trunk is somewhat larger than the dorsal, which lies directly above it. Each approaches very closely to the muscle bundles of the corresponding surface. The nerve lies laterally immediately below the vitellaria, and as previously mentioned is situated just outside of the inner musculature. The genital canals displace the nerve slightly towards the dorsal surface as they

pass below it. Calcareous corpuscles were not seen. The cortex occupies a much greater portion of the section than does the medulla.

Genitalia.—The genitalia alternate irregularly. The pore is located on a very slightly projecting papilla immediately in front of the middle of the edge of the segment. The common cloaca is very shallow, the male aperture more frequently being placed just posteriorly to the female pore. However, the reverse position of the opening is not uncommon. Both are on practically the same dorso-ventral level, the vaginal orifice being sometimes slightly more dorsally situated than the male pore. The sex ducts lie close together in their outer portions, both passing between the excretory vessels and below the lateral nerve and the vitellaria of the corresponding side.

The male glands are scattered to form two extensive testicular fields extending from near the anterior edge of the segment to the ovarian lobes, separated along the middle of the segment by a rather wide interval in which lies the uterus. Each field contains between 36 and 40 vesicles arranged more or less in a single row, though all the glands do not by any means stand at the same level. Their arrangement in the parenchyma is figured in the transverse section in Fig. 3. It will be seen that they occupy a considerable portion of the medulla, and are as a whole almost equidistant from either surface. It was therefore a matter of some difficulty to fix the surfaces as dorsal and ventral respectively. This difficulty was increased by the absence of transverse excretory vessels by which one might identify the ventral vessels, and by the position of the ovarian lobes, which are placed on the same level as the testes. However, the ovarian bridge very closely approaches the opposite surface, which I have accordingly designated the ventral. The testes are about 0.05 mm. in diameter in surface view, their transverse (*i.e.*, dorso-ventral) diameter being greater, reaching 0.082 mm. These glands are practically absent in the region of the genital ducts. The vas deferens is a closely coiled wide tube lying at about the middle of the testicular field on that side of the segment which bears the genital pore. It frequently extends inwards as far as the mid-line, lying dorsally to the uterus. During sexual maturity the coils occupy in transverse section most of the

mid-region of the medulla. The vas is dorsal to the vagina, which passes under it on its way inwards and backwards from the female pore to the ovary. Just before entering the cirrus sac the coils become less numerous, and the vas now passes below the vagina as a narrow tube. Within the sac it becomes considerably coiled and widened again to act as a vesicula seminalis, the coils lying in the inner half of the sac. The eversible portion or cirrus lies introverted within the outer half of the sac, and possesses powerful longitudinal and circular muscles in its wall. The cirrus sac is an elliptical structure with rather weak muscular walls. The whole organ closely resembles that of *P. coryphicephala* (Montic.).* As already mentioned, the sac lies ventrally to the nerve and the vitelline glands. It also usually lies ventrally and parallel to the vagina. The cirrus was seen in a state of eversion only in a few transverse sections, where it appeared as a projection 0.086 mm. long by 0.020 mm. wide. No armature was recognised.

The female glands possess the general characters present in other members of the genus. The ovary is a wide bilobed organ of 0.5 mm. in breath, situated at the posterior end of the segment and extending from the excretory vessels of the one side to those of the other. Each wing is only slightly divided up into ovarian tubes. There is a very narrow bridge connecting the lateral portions, each lobe being situated dorso-laterally in the medulla while the bridge lies quite ventrally, just above the ventral inner longitudinal muscle series. From the middle of the bridge there passes backwards a narrow slightly coiled oviduct which eventually enters the fertilising duct just after the latter penetrates the shell-gland. There is a well-marked swallowing apparatus present on the commencement of the oviduct just behind the ovarian bridge. The oviduct forms a loop, passing forwards and somewhat dorsally to meet the fertilising duct just behind the middle of the ovary. This duct then passes on dorsally to penetrate the shell-gland complex, which lies just behind and dorsally to the ovarian bridge.

The vitellarium consists of a great number of tiny follicles averaging 0.020 mm., and arranged in a longitudinal row in the cortex along each side of the segment, just externally to the main longitudinal musculature and immediately above the nerves. The

* Monticelli, Boll. Soc. Nat. Napoli. Ser. 1, 1891, v, p. 161, etc., and fig. 29.

genital canals pass out ventrally below them. At the posterior end of each row there comes off a delicate vitello-duct which travels inwards between the excretory vessels and downwards so as to pass below the ovarian lobes. The two ducts unite just below and behind the middle of the ovarian bridge to give rise to a short and rather wider common duct which passes directly dorsally to enter the shell-gland complex.

From the female pore the wide vagina passes inwards parallel with and dorsally to the cirrus sac. As already mentioned, this duct rather more frequently lies in front of the male duct. In the outer portion of its course its walls are covered by a layer of deeply staining gland cells similar to those figured by Kraemer* in *P. filicollis*. It passes round close behind the sac crossing dorsally above the vas deferens, which is here very narrow, and then trends inwards and backwards, forming a curve which lies just below the mid-dorso-ventral level and below the main mass of the wide coiled vas deferens. On reaching the mid-line of the segment it travels backwards above the uterus towards the ovary, which it crosses dorsally. Just in front of and behind the ovarian bridge the vagina becomes thrown into a number of loose coils, this portion possessing a rather wider lumen than the more anterior part, and acting as a sperm reservoir. In mature segments there may be readily recognised, lying just behind the ovary, a coiled mass, the constituent parts of which can only be worked out by a careful study of serial sections. The details of the oviduct, vitelline duct, and shell-gland have already been mentioned. The vagina becomes narrowed to form the fertilising duct, which passes dorsally to enter the shell-gland very soon after taking up the oviduct. As stated previously, the common vitelline duct enters the fertilising canal within the shell complex. The uterus travels forwards from the latter as a narrow tube, rising dorsally above the ovary and the vagina, very soon bending ventrally, passing to one side of the vagina and coming to lie just below the inner longitudinal musculature. It then extends forwards along the mid-line, its rounded extremity lying near the anterior border of the segment. The uterus is at first a long, narrow, simple sac, but short lateral diverticula soon appear, these increasing in size as egg formation progresses. As the cavity increases the male and female glands

* Kraemer, Zeitschr. f. wiss. Zool. liii, 1892, p. 647-722.

become more or less displaced and soon atrophy, the testes being the first to disappear. The mature organ consists of a rather long, narrow, median trunk with extensive lateral cavities arranged more or less at right angles to it, the appearance being somewhat like that found in the genus *Tænia sensu stricto*. The lateral pouches are not subdivided. Sometimes the uterus becomes so densely packed with eggs that one cannot recognise the presence of pouches, the organ then resembling a large simple sac such as is found in *Dilepis* and allied Tæniad genera. The eggs are spherical, possessing two shells, the diameter of the outer being 0.039 mm., that of the inner, which closely invests the embryo, being 0.0156 mm. The embryonal hooklets measure 0.0084 mm. in length.

The only other species of *Proteocephalus* known from Australia are *P. tidswelli*, Johnston,* taken from the monitor lizard *Varanus varius*, Shaw, in different parts of New South Wales, and *Proteocephalus* sp. (recorded as *Ichthyotænia* sp.)† from the copper-headed snake *Denisonia superba*, also from that State. Two forms were described from *Varanus* sp., from New Guinea, by Ratz,‡ under *Ichthyotænia*—viz., *P. biroi* and *P. saccifera*. All three described forms, as well as *P. gallardi*, come under the subgenus *Acanthotænia*.§

Linstow,‖ in 1907, in describing *P. pigmentata* (*I. pigmentata*, Linst.), from the intestine of *Psammodynastes pulverulentus*, Fisch., gives a list of the Tæniad cestodes known from snakes, remarking that nearly all of them belong to the genus *Ichthyotænia*. Schwarz¶ has recently published a paper on the Ichthyotæniæ of reptiles, in which he enumerates the known species, and offers observations on the anatomy of some of the species. The life history of members of the group is not known, though Barbieri** regards it as being very probable that the plerocercoid stage of the various species infesting Teleosteans occurs in certain crustacea such as *Leptodora* and *Bythotrephes*.

---

* Johnston, Jour. Proc. Roy. Soc. N.S.W. xliii, 1909, p. 103-116.

† Johnston, *Ibid.* 1910, p. xviii.

‡ Ratz, C. R. Soc. Biol. lii, 1900, p. 980-1; Centr. f. Bakt. xxviii, 1900, p. 657-660.

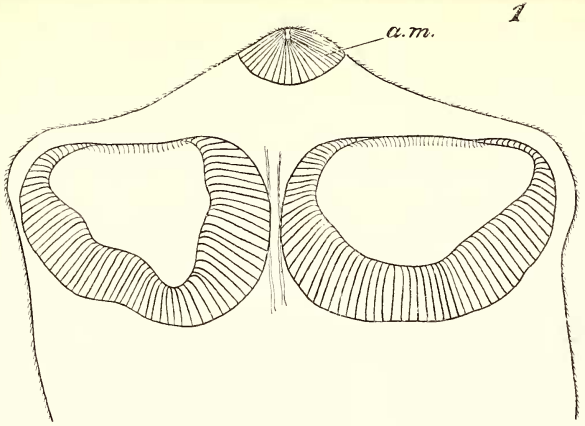
§ Johnston, Jour. Proc. Roy. Soc. N. S. Wales 1910, p. 114-5.

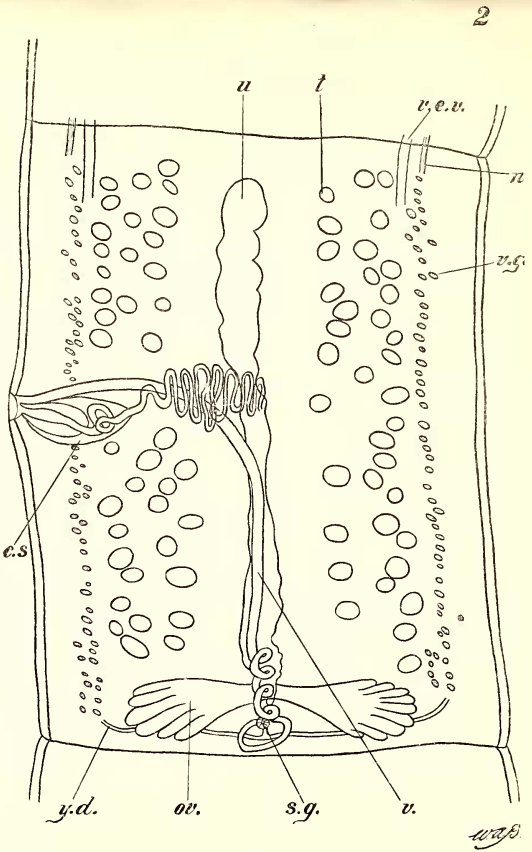
‖ Linstow, Notes from the Leyden Museum, xxix, 1907, p. 85-6.

¶ Schwarz, Die Ichthyotænien der Reptilien, etc. Inaug. Diss. Basel. 1908, p. 1-52; Ref. in Zoolog. Zentralb. xvi, Dec. 1909, p. 801.

** Barbieri, Centr. f. Bakt. Orig. I., xlix, 1909, p. 334-341.

The type slide of *P. gallardi* has been deposited in the Queensland Museum, Brisbane. The material was collected by Messrs. L. Gallard (Gosford district, N.S.W.); C. T. Musson (Richmond, N.S.W.); F. H. Taylor and W. Hall (Hunter River, N.S.W.); A. S. Le Souef (Gippsland, Victoria); and by myself on several occasions from black snakes caught in the vicinity of Sydney.





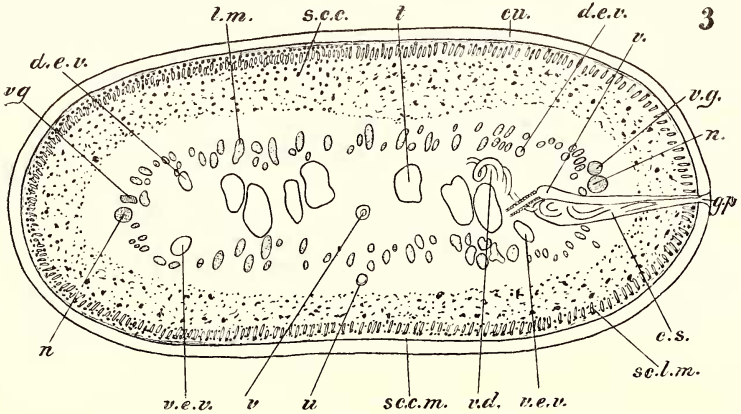


Fig. 1. Scolex. Fig. 2. Sexually mature segment. Fig. 3. Transverse section of segment approaching maturity.

References to lettering :—*a.m.*, apical muscle p'ug ; *c.s.*, cirrus sac ; *cu.*, cuticle ; *d.e.v.*, dorsal excretory vessel ; *g.p.*, genital papilla ; *l.m.*, longitudinal musculature ; *n.*, longitudinal nerve ; *ov.*, ovary ; *s.c.c.*, subcuticular cells ; *sc.c.m.*, subcuticular circular muscle ; *sc.l.m.*, subcuticular longitudinal musculature ; *s.g.*, shell-gland ; *t.*, testis ; *u.*, uterus ; *v.*, vagina ; *v.d.*, vas deferens ; *v.e.v.* ventral excretory vessel ;